AEROSPACE MATERIAL SPECIFICATION

AMS6257™	REV. G

Issued 1990-07
Revised 2022-10

Superseding AMS6257F

Steel Bars, Forgings, Forging Stock, and Mechanical Tubing
1.6Si - 0.82Cr - 1.8Ni - 0.40Mo - 0.08V (0.40 - 0.44C)
Consumable Electrode Vacuum Remelted
Normalized and Tempered

(Similar to UNS K44220)

RATIONALE

AMS6257G is the result of a Five-Year Review and update of the specification. The revision updates the title to match the scope, prohibits unauthorized exceptions (3.7, 4.4.4, 5.2.1.1, 8.7), updates composition testing (3.1, 3.1.1), updates heat treatment requirements (3.3.1, 3.3.2), updates macrostructure examination (3.4.1, 8.9), standardizes wording on decarburization testing (3.4.4.5), adds strain rate control to tensile tests (3.4.5.1.3), updates acceptance testing (4.2.1), adds notes on stock removal (8.6), and allows prior revisions (8.8).

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality, low-alloy steel in the form of bars, forgings, mechanical tubing, and forging stock.

1.2 Application

These products have been used typically for parts under 3.5 inches (89 mm) in thickness requiring a through-hardening steel capable of developing a minimum hardness of 52 HRC, the parts being subject to very rigid magnetic particle inspection standards, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking after heat treatment; ARP1110 recommends practices to minimize such occurrences.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6257G/

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2251 Tolerances, Low-Alloy Steel Bars

AMS2253 Tolerances, Carbon and Alloy Steel Tubing

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

AMS2300 Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure

AMS2310 Qualification Sampling and Testing of Steels for Transverse Tensile Properties

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2372 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings

AMS2750 Pyrometry

AMS2761 Heat Treatment of Steel Raw Materials

AMS2806 Identification Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels, and Corrosion- and Heat-Resistant Steels and Alloys

AMS2808 Identification Forgings

ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion-Resistant Steels and Alloys

AS1182 Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel, Bars and Mechanical Tubing

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A370 Mechanical Testing of Steel Products

ASTM A604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets

ASTM A751 Chemical Analysis of Steel Products

ASTM E45 Determining the Inclusion Content of Steel

ASTM E112 Determining Average Grain Size

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E1077 Estimating the Depth of Decarburization of Steel Specimens

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods approved by purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.40	0.44
Manganese	0.65	0.90
Silicon	1.45	1.80
Phosphorus	--	0.010
Sulfur	--	0.008
Chromium	0.70	0.95
Nickel	1.65	2.00
Molybdenum	0.35	0.45
Vanadium	0.05	0.10
Copper	--	0.35

3.1.1 Producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection, unless limits of acceptability are specified by the purchaser.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259, except that check analysis limits for carbon shall be 0.01 under minimum or over maximum.

3.2 Melting Practice

Steel shall be multiple melted using vacuum consumable electrode practice in the remelt cycle.

3.3 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.3.1 Bars and Tubing

Normalized and tempered at a temper temperature not higher than a furnace setpoint of 1250 °F (677 °C). Pyrometry shall be in accordance with AMS2750. Bar shall not be cut from plate (also see 4.4.2).

3.3.1.1 Bars 0.500 Inch (12.70 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides

Cold finished having tensile strength not higher than 130 ksi (896 MPa) or equivalent hardness (see 8.2).

3.3.1.2 Bars Over 0.500 Inch (12.70 mm) in Nominal Diameter or Least Distance Between Parallel Sides

Hot finished unless otherwise ordered, having hardness not higher than 341 HB or equivalent (see 8.3). Bars ordered cold finished may have hardness as high as 341 HB (see 8.3).

3.3.1.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 341 HB or equivalent (see 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 99 HRB or equivalent (see 8.3).

3.3.2 Forgings

Normalized and tempered in accordance with AMS2761 to a hardness not higher than 341 HB or equivalent (see 8.3).

3.3.3 Forging Stock

As ordered by the forging manufacturer.

3.4 Properties

The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.4.1 Macrostructure

Visual examination of transverse sections from bars, billets, tube rounds (solid not hollow), and forging stock, etched in hot hydrochloric acid in accordance with ASTM A604, shall not show pipe or cracks. Porosity, segregation, inclusions, and other imperfections for product 144 square inches (929 cm^2) and under in nominal cross-sectional area shall not be worse than the macrographs of ASTM A604 shown in Table 2.

Table 2 - Macrostructure limits

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	B
4	Ring Pattern	B

3.4.1.1 Macrostructure examination is not required for bored/hollow forgings (including ring forgings) and mechanical tubing that is produced directly from ingots or large blooms (see 8.9).

3.4.1.2 If mechanical tubing is produced directly from ingots or large blooms, transverse sections may be taken from the tubing. Macrostructure standards for such tubes shall be as agreed upon by purchaser and producer (see 8.9).

3.4.2 Micro-Inclusion Rating of Each Heat

No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E45, Method D.

Table 3 - Micro-inclusion rating limits

Type	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency, Maximum	a	1	a	1	a	1	3	1
Total Rateable Fields, Frequency, Maximum	b	1	b	1	b	1	8	1

a - Combined A+B+C, not more than three fields.
b - Combined A+B+C, not more than eight fields.

3.4.2.1 A rateable field is defined as one which has a Type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with ASTM E45.

3.4.3 Average Grain Size of Bar, Forgings, and Tubing

Shall be ASTM 6 or finer, determined in accordance with ASTM E112.

3.4.4 Decarburization

3.4.4.1 Bars and tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization on tubing ID shall not exceed the maximum depth specified in Table 5.

3.4.4.2 Allowable decarburization of bars, billets, and tube rounds ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by purchaser and producer.

3.4.4.3 Decarburization of bars that 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table 4.

Table 4A - Maximum decarburization, inch/pound units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inches
Up to 0.375, incl	0.010
Over 0.375 to 0.500, incl	0.012
Over 0.500 to 0.625, incl	0.014
Over 0.625 to 1.000, incl	0.017
Over 1.000 to 1.500, incl	0.020
Over 1.500 to 2.000, incl	0.025
Over 2.000 to 2.500, incl	0.030
Over 2.500 to 3.000, incl	0.035
Over 3.000 to 5.000, incl	0.045

Table 4B - Maximum decarburization, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 9.52, incl	0.25
Over 9.52 to 12.70, incl	0.30
Over 12.70 to 15.88, incl	0.36
Over 15.88 to 25.40, incl	0.43
Over 25.40 to 38.10, incl	0.51
Over 38.10 to 50.80, incl	0.64
Over 50.80 to 63.50, incl	0.76
Over 63.50 to 76.20, incl	0.89
Over 76.20 to 127.00, incl	1.14

3.4.4.4 Decarburization of tubing that 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table 5.

Table 5A - Maximum decarburization, inch/pound units

Nominal Wall Thickness Inches	Total Depth of Decarburization Inches ID	Total Depth of Decarburization Inches OD
Up to 0.109, incl	0.008	0.015
Over 0.109 to 0.203, incl	0.010	0.020
Over 0.203 to 0.400, incl	0.012	0.025
Over 0.400 to 0.600, incl	0.015	0.030
Over 0.600 to 1.000, incl	0.017	0.035
Over 1.000	0.020	0.040

Table 5B - Maximum decarburization, SI units

Nominal Wall Thickness Millimeters	Total Depth of Decarburization Millimeters ID	Total Depth of Decarburization Millimeters OD
Up to 2.77, incl	0.20	0.38
Over 2.77 to 5.16, incl	0.25	0.51
Over 5.16 to 10.16, incl	0.30	0.64
Over 10.16 to 15.24, incl	0.38	0.76
Over 15.24 to 25.40, incl	0.43	0.89
Over 25.40	0.51	1.02

3.4.4.5 Decarburization shall be evaluated by one of the two methods of 3.4.4.5.1 or 3.4.4.5.2.

3.4.4.5.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be prepared in accordance with ASTM E1077, etched, and visually examined metallographically at a magnification not to exceed 200X. The product shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Tables 4 and 5.

3.4.4.5.2 Hardness Traverse (Microindentation) Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened in a protective atmosphere to prevent changes in surface carbon content. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Tables 4 and 5.

3.4.4.5.3 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the above limits by more than 0.005 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.4.4.5.4 In case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

3.4.5 Response to Heat Treatment of Bars, Forgings, and Tubing

Specimens shall conform to the following requirements after being normalized by heating to 1700 °F ± 25 °F (927 °C ± 14 °C), holding at heat for 60 minutes ± 5 minutes, and cooling in air; hardened by heating to 1600 °F ± 25 °F (871 °C ± 14 °C), holding at heat for 60 minutes ± 5 minutes, and quenching in oil; and double tempered by heating to 575 °F ± 10 °F (302 °C ± 6 °C), holding at heat for 2 hours ± 0.2 hour, cooling in air to room temperature, reheating to 575 °F ± 10 °F (302 °C ± 6 °C), holding at heat for 2 hours ± 0.2 hour, and cooling at a rate equivalent to cooling in air.

3.4.5.1 Tensile Properties

3.4.5.1.1 Longitudinal

Shall be as shown in Table 6; testing in the longitudinal direction need not be performed on product qualified by testing in the transverse direction.

Table 6 - Minimum longitudinal tensile properties

Property	Value
Tensile Strength	280 ksi (1931 MPa)
Yield Strength at 0.2% Offset	230 ksi (1586 MPa)
Elongation in 4D	8%
Reduction of Area	30%

3.4.5.1.2 Transverse

Shall be as shown in Table 7, determined on specimens selected and prepared in accordance with AMS2310 for premium aircraft-quality steels.

Table 7A - Transverse tensile properties, inch/pound units

Nominal Cross-Sectional Area Square Inches	Tensile Strength ksi Min	Tensile Strength ksi Max	Yield Strength at 0.2% Offset ksi, Min	Reduction of Area %, Min Average	Reduction of Area %, Min Individual Value
Up to 100, incl	280	305	230	30	25
Over 100 to 144, incl	280	305	230	25	20
Over 144	280	305	230	20	15

Table 7B - Transverse tensile properties, SI units

Nominal Cross-Sectional Area Square Centimeters	Tensile Strength MPa Min	Tensile Strength MPa Max	Yield Strength at 0.2% Offset MPa, Min	Reduction of Area %, Min Average	Reduction of Area %, Min Individual Value
Up to 645, incl	1931	2103	1586	30	25
Over 645 to 929, incl	1931	2103	1586	25	20
Over 929	1931	2103	1586	20	15

3.4.5.1.3 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 in/in (0.05 and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min).

3.5 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.5.1 Steel shall be premium aircraft-quality conforming to AMS2300, except that a maximum average frequency (F) rating of 0.10 and a maximum severity (S) rating of 0.20 shall apply.

3.5.2 Bars and mechanical tubing shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

3.5.3 Grain flow of die forgings, except in areas that contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.6 Tolerances

3.6.1 Bars

In accordance with AMS2251.

3.6.2 Mechanical Tubing

In accordance with AMS2253.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.4.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), condition (3.3), macrostructure (3.4.1), micro-inclusion rating (3.4.2), average grain size (3.4.3), decarburization (3.4.4) response to heat treatment (3.4.5) and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Frequency-severity rating (3.5.1) and grain flow of die forgings (3.5.3) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

4.3.1 Bars, Mechanical Tubing, and Forging Stock

In accordance with AMS2370.

4.3.2 Forgings

In accordance with AMS2372.

4.4 Reports

4.4.1 The producer of bars, forgings, and mechanical tubing shall furnish with each shipment a report showing the producer identity, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), the results of tests for composition, macrostructure and micro-inclusion rating of each heat and for condition, average grain size and response to heat treatment of each lot and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS6257G, product form and size (and/or part number, if applicable), and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.